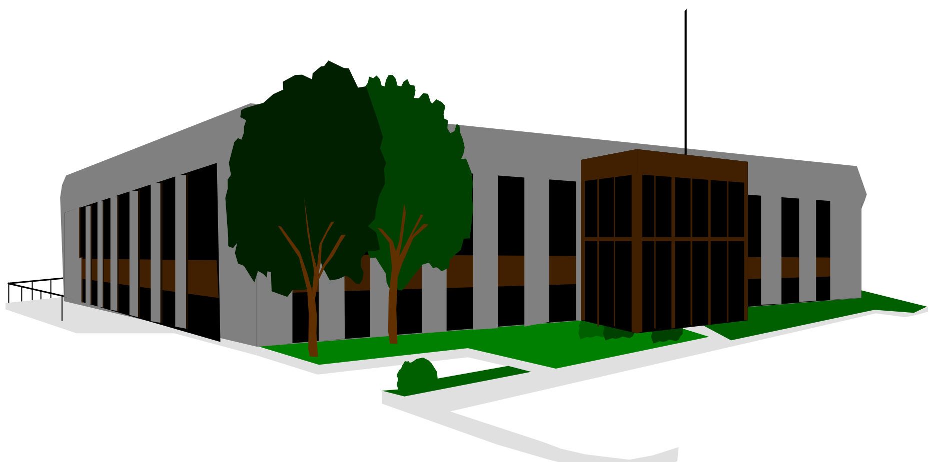
INDOOR AIR QUALITY ASSESSMENT

Greenfield Town Hall Annex
253 Main Street
Greenfield, Massachusetts



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Bureau of Environmental Health Assessment

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Background/Introduction

At the request of Lisa Herbert, Greenfield Board of Health, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Greenfield Town Hall Annex (the annex), 253 Main Street, Greenfield, Massachusetts. On July 5, 2001, a visit was made to this building by Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA to conduct an indoor air quality assessment. During the visit BEHA staff received complaints from building occupants of poor indoor air quality.

The annex is a one-story red brick building, which was originally constructed as a stand-alone building in the 1930s, and served as the Greenfield Police Station. The annex underwent at least two renovations. The first renovation connected the police station to the Greenfield Town Hall, possibly constructed in the 1960s (see Picture 1, Figure 1). The second renovation reconfigured garages that existed in the rear of the building (see Picture 2). One garage bay was enclosed to create office space. The renovation also sealed windows in the abandoned cellblock and installed a mechanical ventilation system. Currently, the building is used as space for Greenfield town offices. The basement floor is used for storage of town records. Also contained in the basement is the former firearms range used by the Greenfield Police Department. Windows are openable and consist of single paned glass in wooden window frames.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

These offices have an employee population of approximately 10. The tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million of air (ppm) in all areas sampled, indicating adequate air exchange. The original police station used a combination of openable windows for fresh air and turbine vents (see Picture 3) installed in skylights for exhaust ventilation. A the time of the assessment, the annex staff used a combination of window and wall-mounted air conditioners to provide cooling and the skylight-mounted turbine vents for exhaust ventilation.

The annex appears to have been equipped with a mechanical ventilation system (see Figure 2). An air handling unit (AHU) was located above the suspended ceiling in a restroom (see Picture 4). The AHU is connected to a fresh air intake located near the back corner formed by the police station and the 1960s addition (see Picture 5, Figure 2). The AHU was deactivated by the cutting of its power cord (see Picture 6). It appears that the AHU is connected to ceiling-mounted fresh air diffusers that are in the front of the building. It is possible that this system was disconnected to prevent the entrainment of vehicle exhaust from idling vehicle parked beneath the fresh air intake when the building was used as the police station. A large exhaust fan was installed in the rear of the annex (see Pictures 7 and 8). It appears that the operation of the exhaust fan was intended to draw fresh air from the front of the building into the rear offices (see Figure 2). In the current condition, no fresh air is provided for the meeting room, front lobby/meeting area nor the front private office. By forcing air into the front of the building, the pressurization of the interior space would aid in forcing exhaust pollutants out of the roof mounted skylight vents and into the cellblock area.

Several offices do not seem to be connected to this abandoned ventilation system. The sole source of fresh air is through openable windows. With the lack of an operable ventilation system, pollutants that exist in the interior space can build up and remain inside the building, leading to indoor air quality/comfort complaints.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings were measured in a range of 74° F to 79° F, the majority of which were within the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building was above the BEHA recommended comfort range of 40 to 60 percent in some areas sampled the day of the assessment. Relative humidity measurements ranged from 45 to 76 percent. Moisture removal is important since the sensation of heat increases as relative humidity increases (the relationship between temperature and relative humidity is called the heat index). As temperature indoors rises, the addition of more relative humidity will make occupants feel hotter. If moisture is removed, the comfort of the individuals is increased. Removal of moisture from the air, however, can have some negative effects. The sensation of dryness and irritation is common in a low relative humidity environment. Humidity is more difficult to control during the winter heating season when relative humidity levels would be expected to drop. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

This assessment occurred on a humid summer day (70%). With the combination of inactive ventilation systems and open exterior doors and windows, relative humidity levels can become elevated indoors. While temperature is mainly a comfort issue, relative humidity in excess of 70% can provide an environment for mold and fungal growth (ASHRAE, 1989). During periods of high relative humidity (late spring/summer months), windows and exterior doors should be closed to keep moisture out; in addition, AHUs, univents and exhaust ventilation should be activated to control moist air in the building.

Microbial/Moisture Concerns

A number of areas have wall-mounted air conditioners (WMACs). The meeting room has a WMAC installed through the front exterior wall within a metal sleeve. The metal sleeve should be beveled to allow for condensation to drain to the ground. The metal sleeve is beveled toward the WMAC, allowing condensation to drain into the interior wall (see Picture 9). The interior wall of the meeting room is made of gypsum wallboard (GW). If GW becomes chronically moistened, it can become a mold growth medium. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Once mold growth has occurred, disinfection of these materials may be possible, however since GW is a porous surface, disinfection is likely to be ineffective.

The community development office appears to have water penetration through the door frame as noted by signs of water damage to the exterior of the door and water damage to the carpet. As with other porous building materials, if carpets are not dried within 24 hours, mold growth may occur. Water-damaged carpeting cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy carpeting is not recommended.

Several notable conditions concerning roof water drainage were observed. Both efflorescence (see Pictures 10 and 11) and water damage to wood forming the soffit of the roof (see Picture 12) were noted, which can indicate chronic exposure to rainwater penetrating beneath the flashing along the edge of the roof. Efflorescence is a characteristic sign of water damage to brick and mortar, but it is not mold growth. As moisture penetrates and works its way through mortar around brick, water-soluble compounds in bricks and mortar dissolve, creating a solution. As the solution moves to the surface of the brick or mortar, the water evaporates, leaving behind white, powdery mineral deposits. Over time, this condition can result in the breakdown of brick and mortar. This condition can indicate that roof drainage is inadequate. Two areas of the roof have large patches of moss (see Picture 13), which may indicate the location of blocked roof drains. Pooling water on a flat roof can lead to damage during the winter. Water can penetrate into cracks on roof material or flashing, which then can freeze and thaw, resulting in damage to these materials.

The human resources office has a water cooler that is located over wall-to-wall carpeting. The carpet below the water dispensing nozzles was observed to be wet at the time of the BEHA inspection. As previously mentioned, carpet can serve as media for mold growth, especially if repeatedly wetted.

Shrubbery in direct contact with the exterior wall brick was noted in several areas around the building (see Picture 14). Shrubbery can serve as a possible source of water impingement on the exterior curtain wall of the building. Plants retain water and in some cases can work their way into mortar and brickwork causing cracks and fissures, which may subsequently lead to water penetration and possible mold growth.

Opportunity for water penetration through the building envelope exists along the exterior wall/tarmac junction. Plants were noted growing in this area (see Picture 15). Water can gather in the wall/tarmac seam. Freezing and thawing of pooled water can result in damage to the exterior wall, which can lead to water penetration into the building.

Other Concerns

The location of the fresh air intake would indicate that this system was deactivated due to entrainment of vehicle exhaust from idling vehicles. Under certain weather conditions this may provide opportunities for exposure to combustion products such as carbon monoxide. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL, 1986).

No means for installing air filters in the deactivated AHU could be identified. In this condition dust, dirt and other debris can be re-aerosolized by the ventilation system. In order to decrease aerosolized particulates, disposable filters with a higher dust spot efficiency should be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced by the unit due to increased resistance (called pressure drop). Prior to any increase of filtration, the AHU should be evaluated by a ventilation engineer to ascertain whether it can maintain function with higher efficiency filters.

A number of unused floor drains and toilets exist in the former lock up. Without draining water, each of these can potentially have dry drain traps. If drain traps dry out, sewer gas can back up the drains and enter occupied areas. In an effort to prevent odors from penetrating into occupied space, the entrance is sealed polyethylene plastic and duct tape (see Picture 16). Sewer gas can create nuisance odors and be irritating to certain individuals.

Enhancing the accumulation of odors in the cell block is the lack of exhaust ventilation. A skylight vent (see Picture 13) exits in the ceiling of the cell block. If this vent is closed, no means for exhausting odors from the cell block exists. If the retrofitted exhaust vent in the OPCD office is operated, this fan will tend to draw cell block odors into the occupied areas.

The basement contains an area that formally served as a firing range for the Greenfield Police Department. This area is now used as storage. The firing range has an operating exhaust ventilation system. The terminus for the exhaust system is a subterranean pit located in the cul-de-sac formed by the annex and the Greenfield Town Hall. The use of firearms can produce lead contamination of firing ranges. Lead exposure to women who have the potential of being pregnant poses a number of risks to the developing fetus (ATSDR, 1999). Lead exposure, particularly in the early stages of pregnancy when women may not know that they are pregnant, may result in adverse effects from *in utero* exposure to lead. Lead exposure in males has been associated with reduced fertility because of effects on sperm (ATSDR, 1999). It is highly recommended that pregnant employees do not access the former firing range area. All individuals who have access to this area should increase hand and face washing in order to reduce exposure from residual lead that may contaminate flat surfaces.

Offices within the building contain computers, photocopiers and fax machines. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt-Etkin, D., 1992). As discussed previously, without mechanical ventilation, excess heat, odors and pollutants produced by office equipment can build up and lead to indoor air quality complaints.

Conclusions/Recommendations

The lack of mechanical fresh air supply and exhaust ventilation in the areas evaluated makes control of the comfort of individuals in these offices difficult, particularly with windows sealed with WMACs. In order to address the conditions listed in this assessment, the following recommendations should be made to improve indoor air quality. Some recommendations can be implemented as soon as possible, while other solution measures are more complex and will require planning and resources to adequately address the overall indoor air quality concerns. In view of the findings at the time of the visit, the following recommendations are made:

1) Restore the bevel of the meeting room WMAC to drain condensation outdoors. Examine the GW around the WMAC and if moldy, remove.
2) Restore the fresh air supply system. If restoration occurs, consideration should be given to either:
    a) Extending the fresh air intake to rooftop level to prevent vehicle/restroom exhaust entrainment, or

b) Preventing vehicles from parking in this area and reconfiguring the restroom exhaust vent to expel air in a direction away from the fresh air intake.

3) Ensure that a means to install disposable filters of a sufficient dust spot efficiency is provided in the AHU to remove outdoor particles from fresh air.

4) Consider installing a fresh air supply vent to service the office in the front of the building. Consideration should also be given to installing a fresh air supply louver in the central section of the annex to aid in pressurization of the occupied space of the building.

5) Once the fresh air supply system is reestablished, the system should operate to pressurize the occupied offices within the old police station. The existing exhaust vent system in the rear of the building should not operate in a manner to depressurize the rear offices, since this condition would result in the drawing of air through the adjacent garage as well as air from the cellblock.

6) To aid exhaust ventilation, consider installing motorized exhaust fans in the skylight exhaust vents.

7) For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is

recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

8) Remove moss from the roof. If roof drains exist under moss, clear blockages and repair. Inspect periodically for proper function.

9) Remove plants from the exterior wall/tarmac junction.

10) Clean and repair roof gutter to aid rainwater drainage.

11) Improve drainage along the exterior wall to direct rainwater away from the base of the building.

12) Cut back shrubbery a minimum of three feet to prevent water impingement on exterior brickwork.

13) Examine the feasibility of providing local exhaust ventilation for the photocopier.

14) Continue to operate firearms range exhaust vent. Restrict access to the firing area in a manner described earlier in this report. If this area is proposed for use, it is highly recommended that it be evaluated for lead contamination.

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Figure 1
Configuration of the Town Hall Annex to Town Hall

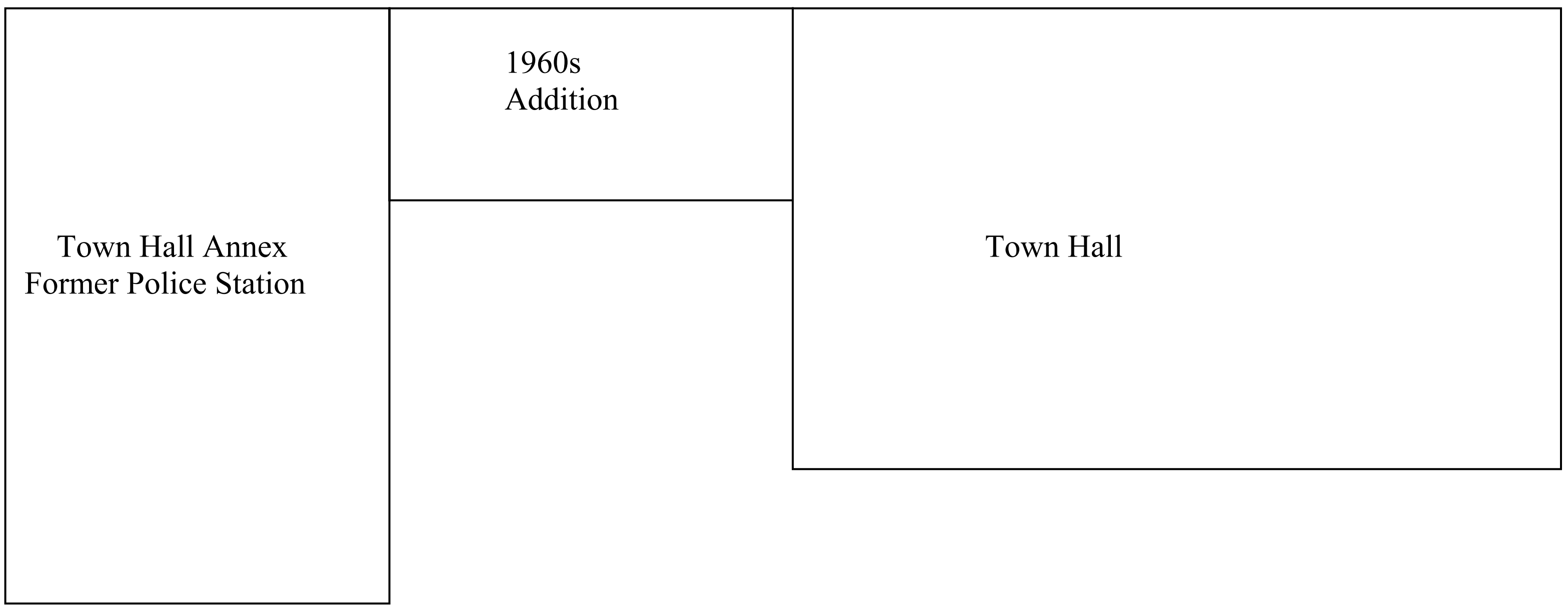
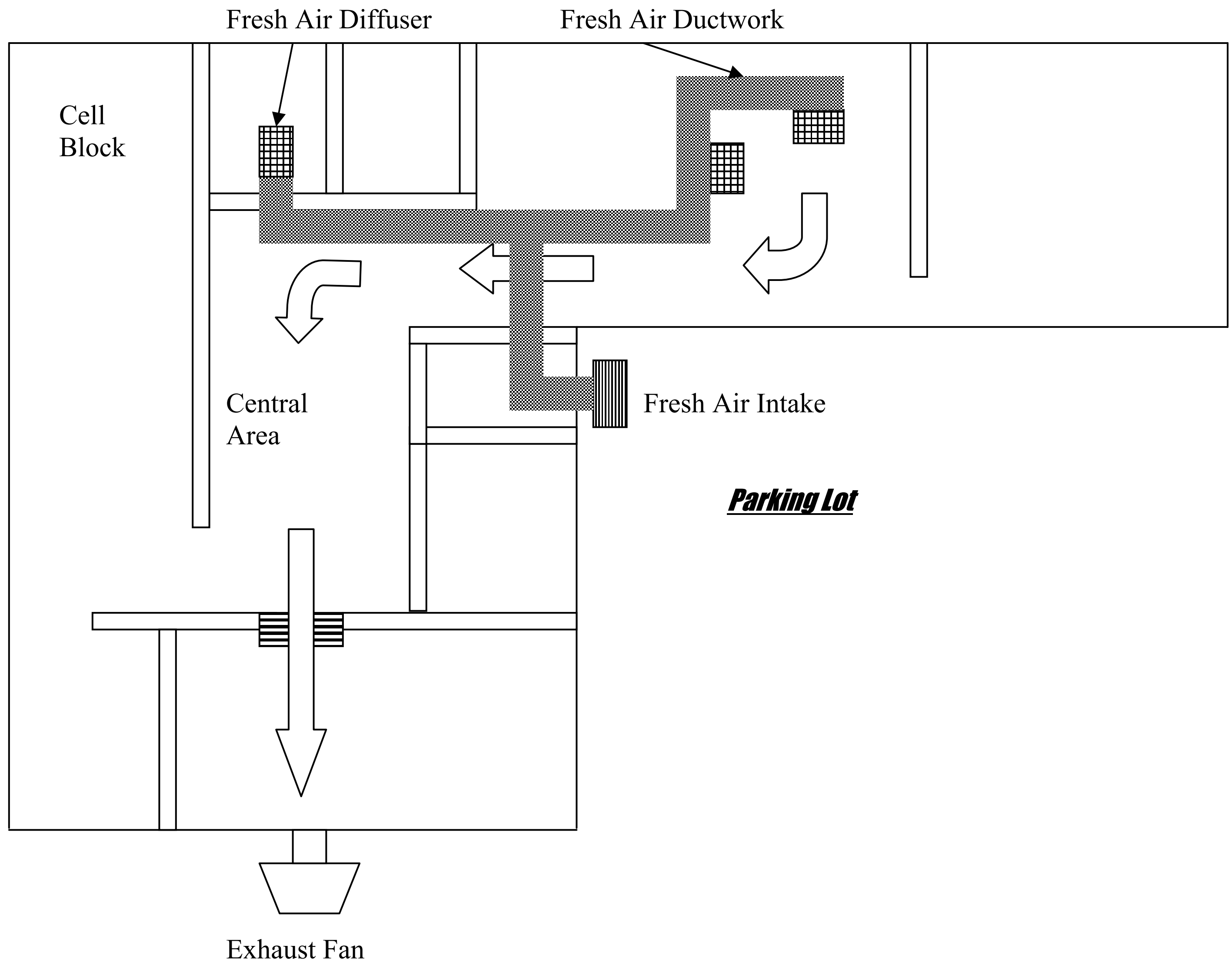


Figure 2
Configuration of Town Hall Annex Ventilation System



Picture 1

The First Renovation Connected The Police Station To The Greenfield Town Hall

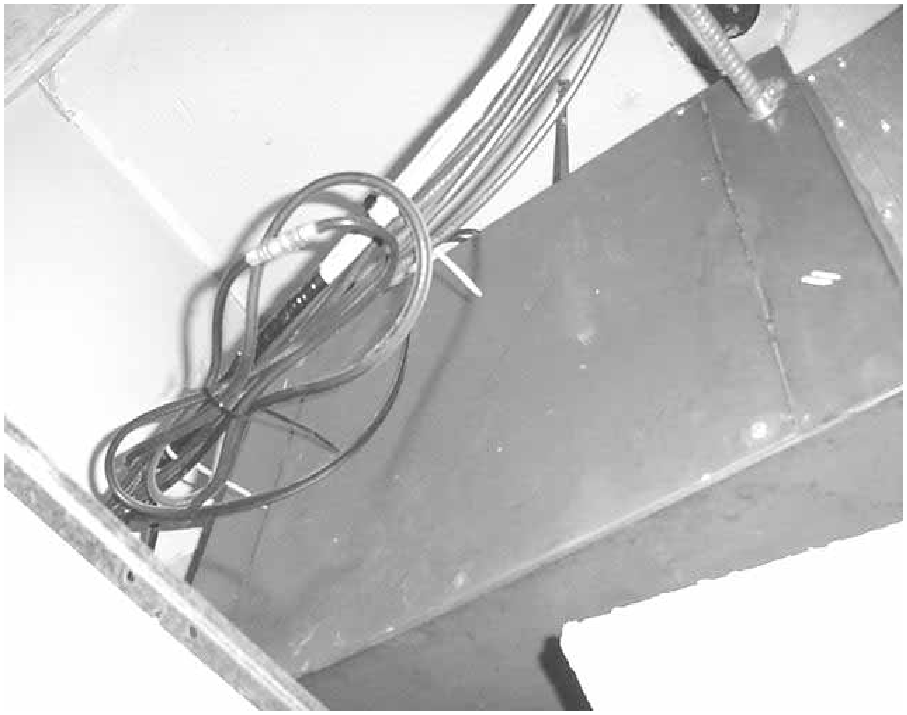
Picture 2

Garages Reconfigured Into Office Space

Picture 3

Turbine Vents On Roof Of Annex

Picture 4

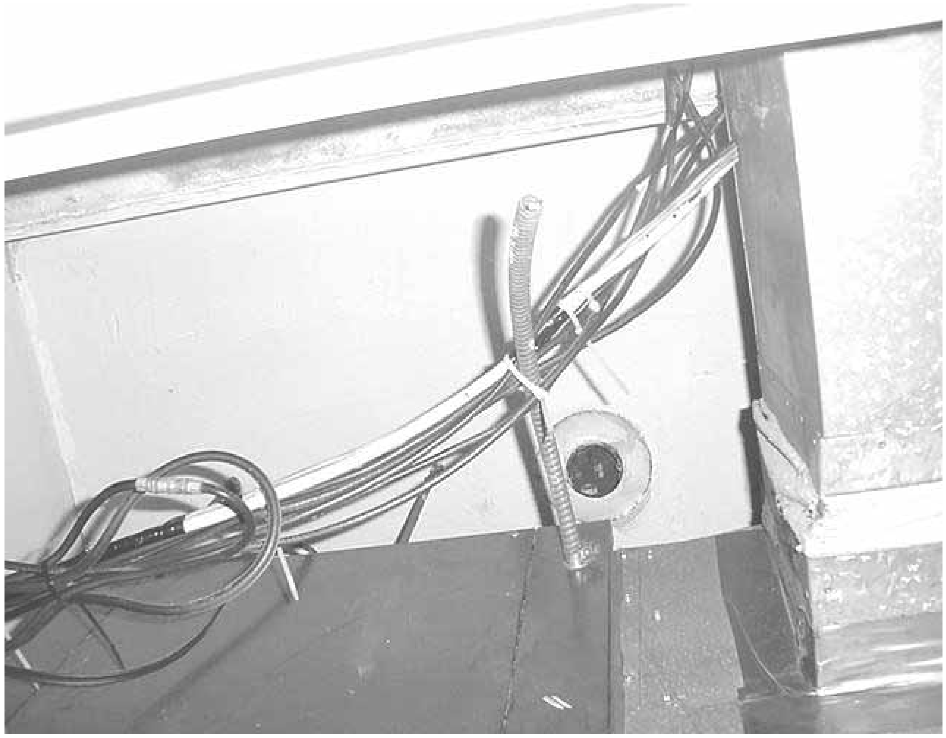


Air Handling Unit (AHU) Located Above The Suspended Ceiling In A Restroom

Picture 5

This AHU Is Connected To A Fresh Air Intake Located Near The Back Corner Formed By The Police Station And 1960s Addition

Picture 6



The AHU Was Deactivated By The Cutting Of Its Power Cord

Picture 7

Exhaust Vent Grill Connected To The Large Exhaust Fan Installed In The Rear Of The Annex

Picture 8

Large Exhaust Fan Installed In The Rear Of The Annex

Picture 9

Metal Sleeve Is Beveled Toward The WAC Allowing Condensation To Drain Into The Interior Wall, Note Accumulated Moisture At Base Of WAC

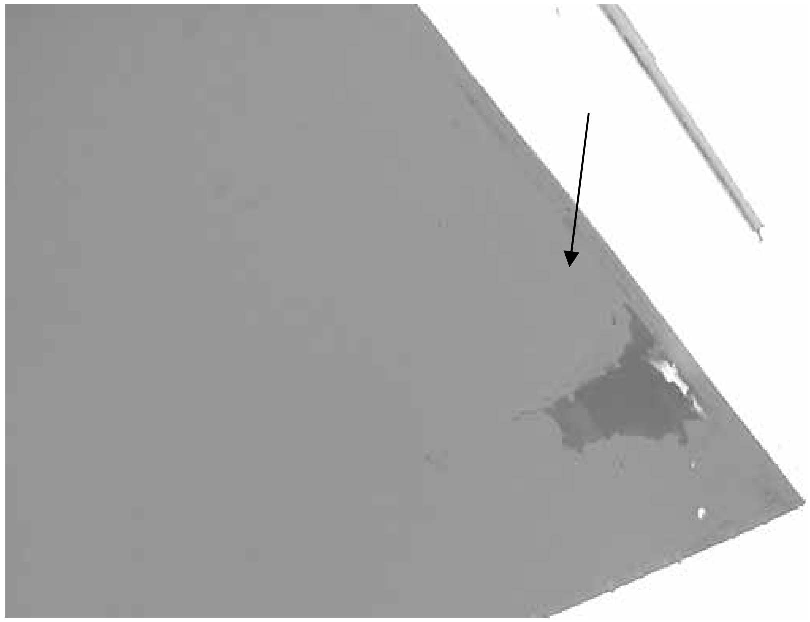
Picture 10

Efflorescence On Brick

Picture 11

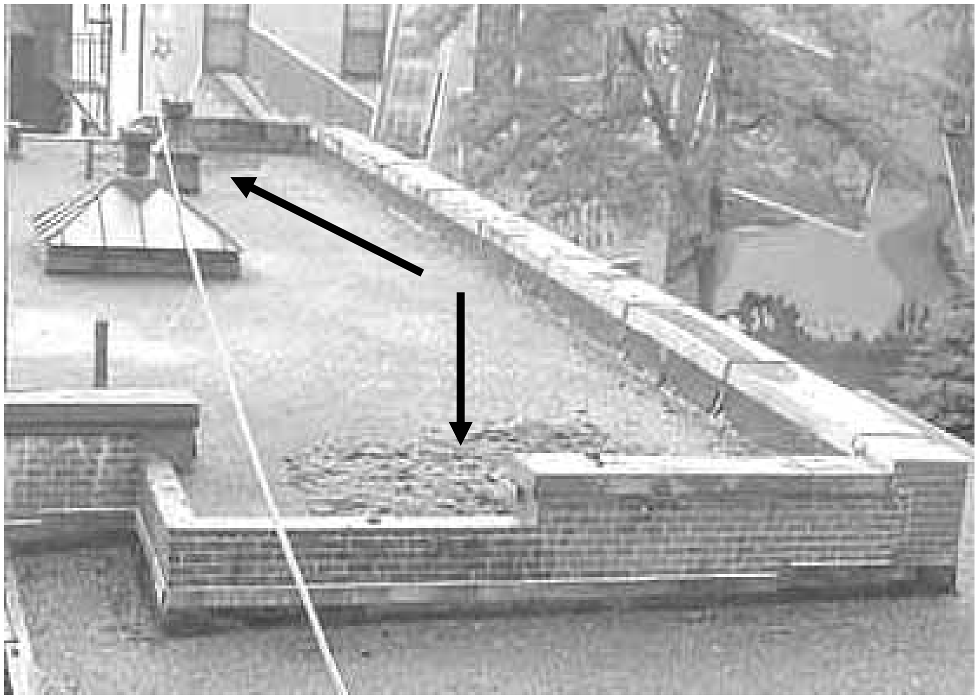
Efflorescence/Pooling Water On Roof

Picture 12



Water Damage To Wood Forming The Soffit Of The Roof

Picture 13



Two Large Patches Of Moss On Annex Roof

Picture 14

Shrubbery In Direct Contact With The Exterior Wall Brick

Picture 15

Plants In The Wall/Tarmac Seam
Beneath The Grille Is The Exhaust Vent For The Basement Firearms Range

Picture 16

Entrance To The Cellblock Sealed With Polyethylene Plastic And Duct Tape

TABLE 1

Indoor Air Test Results – Greenfield Town Hall Annex, Greenfield, MA – July 5, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	502	73	70					
Meeting Room	569	78	57	0	No	Yes	Yes	Supply and exhaust off, WAC on-condensation pan towards wall, floor fan on, door open
Outer Lobby	533	79	59	0	No	Yes	No	Supply off, photocopier
Community Development	708	77	45	2	No	No	No	WAC-on, water cooler on carpet, soda cans
Planning Office (outer)	579	77	54	1	Yes	No	Yes	WAC and floor fan-on, door open
Planning Office (inner)	666	76	66	1	Yes	No	Yes	Exhaust sealed, window and door open
OPCD Director's Office	522	78	66	1	Yes	No	No	
Human Resources	605	74	76	1	Yes	No	No	Window open, water cooler on carpet
Jail								Abandoned floor drains

*** ppm = parts per million parts of air**
CT = ceiling tiles
WAC = wall mounted air conditioner

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%